2-D and 3-D TCAD simulations of defect-tolerant solar cell architectures

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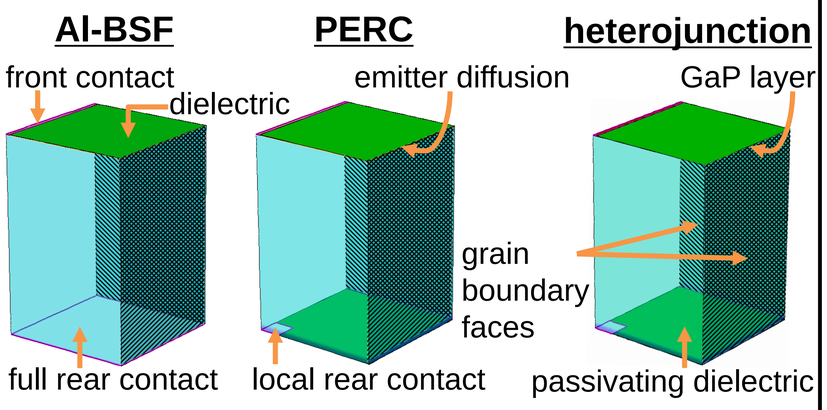
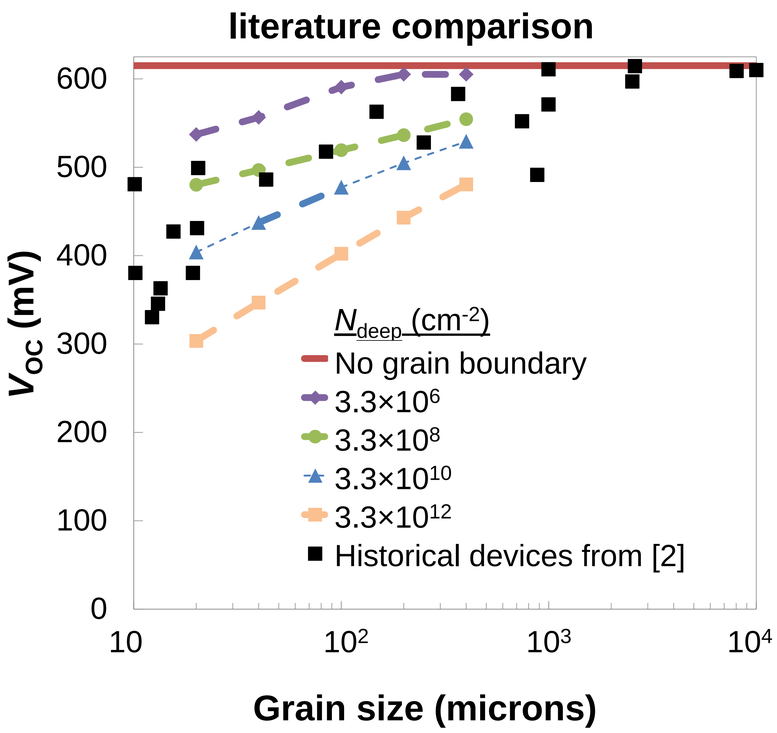
- We use 2-D and 3-D TCAD simulations in Sentaurus Device to determine the injection-dependent device performance impacts of point defects (*e.g.*, Fe_i) and extended defects (*e.g.*, grain boundaries).
- We identify features of device design that contribute to defect tolerance.

grain boundary model

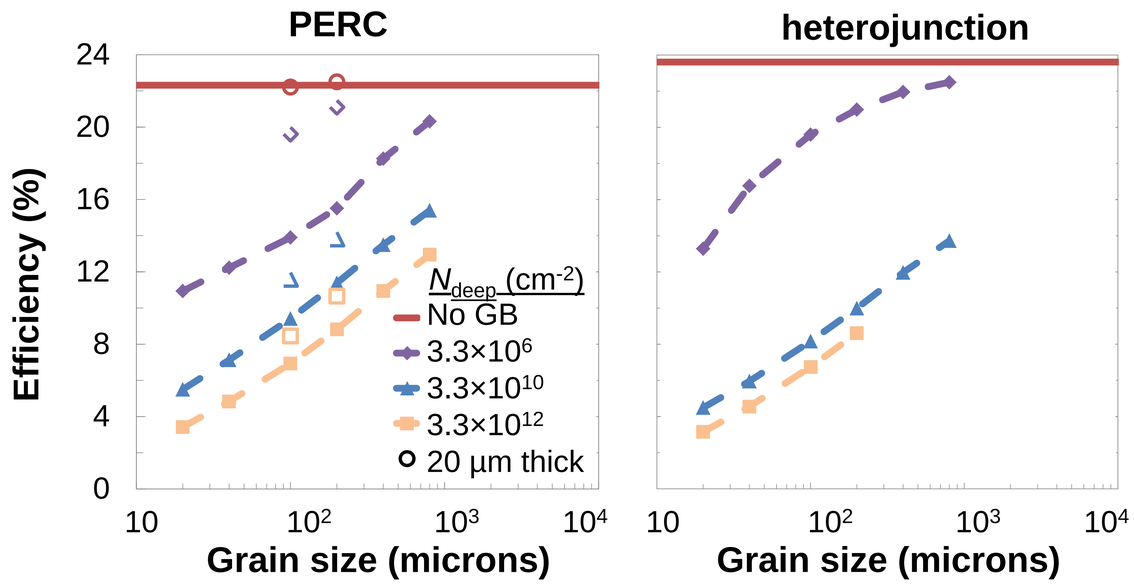


- We model grain boundaries in 3-D as mid-gap recombination centers (N_{deep}) at an interface 2 nm from the simulated domain boundary [1].
- Modified capture cross-sections account for defect charging.

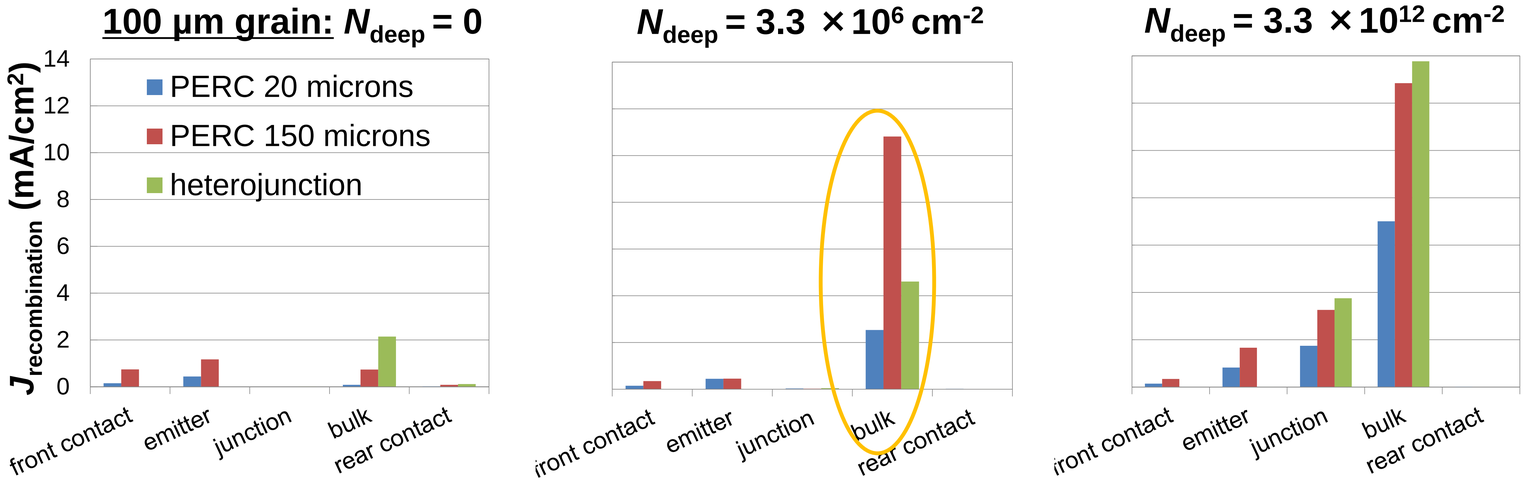


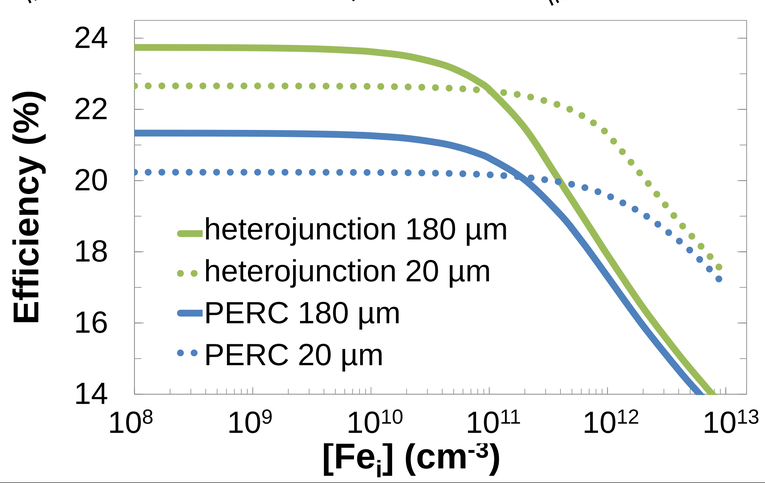
- Our simulated Al-BSF device agrees well with experimental results from literature [2].

heterojunction *vs.* thick and thin PERC



- Heterojunction more tolerant to N_{deep} at grain boundary.
- 20 µm thin PERC more defect-tolerant at all decoration concentrations.
- ↑ injection → ↓ charging → ↓ bulk recombination in heterojunction.
- 20 µm thin PERC *not* in high injection.





- Higher injection levels also reduce the impact of point defects.
- Thinner devices:
  1) are higher-injection
  2) have a smaller volume of defective material
  3) require shorter diffusion lengths

References:

[1] D. Berney Needleman, H. Wagner, P.P. Altermatt, and T. Buonassisi, *Energy Procedia* (accepted) DOI: 10.1016/j.egypro.2015.07.003.

[2] P.P. Altermatt and G. Heiser, *J. Appl. Phys.* **91** 4271 (2002).

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